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Addenda to Allied Medical Publication 8, "NATO Planning Guide for the Estimation of Chemical, Biological, Radiological, and Nuclear (CBRN) Casualties" *(AMedP-8(C))* – Parameters for Estimation of Casualties from Exposure to Specified Biological Agents

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January 2011

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Executive Summary

The North Atlantic Treaty Organization (NATO) *Allied Medical Publication 8(C), NATO Planning Guide for the Estimation of CBRN Casualties* (*AMedP-8(C)*) currently describes a methodology for estimating the numbers of persons developing illness or dying from anthrax, botulism, Venezuelan equine encephalitis, plague, and smallpox. Five additional biological warfare agents have recently been modeled according to the same methodology; these consist of the causative agents of brucellosis, glanders, Q fever, and tularemia, as well as the biotoxin staphylococcal enterotoxin B. Incorporating these five agents into the published NATO guide will require substantial changes to several chapters of the document as well as three of its annexes.

This document presents the text, tables, and figures that will need to be added to *AMedP-8(C)* if these agents are integrated into the document. Each chapter of this document contains the addenda to one chapter or annex in *AMedP-8(C)*, and sections are written to be consistent with the existing contents of the NATO document. In addition to the addenda themselves, this document provides instructions on where to add each new section to facilitate the process of updating *AMedP-8(C)* with the five recently modeled agents.

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1. Introduction

The North Atlantic Treaty Organization (NATO) *Allied Medical Publication 8, NATO Planning Guide for the Estimation of CBRN Casualties* (referred to in this document as *AMedP-8(C)*), describes a methodology for estimating casualties resulting from chemical, biological, radiological, or nuclear (CBRN) attacks on military populations. In addition to the overall methodology, *AMedP-8(C)* presents the specific parameters necessary to model the human response to five biological agents. In anticipation of the desire to expand the scope of this guide in the future, the Institute for Defense Analyses (IDA) has developed parameters consistent with the *AMedP-8(C)* methodology for an additional five biological agents, which are published in IDA Document D-4132, *Parameters for Estimation of Casualties from Exposure to Specified Biological Agents: Brucellosis, Glanders, Q Fever, SEB, and Tularemia*. This document describes the research methods used by the study authors, their analysis of the relevant data for each of the five disease submodels for each agent, and finally their recommended sets of parameters to characterize each disease.

The objective of the current document is to present the text, tables, and figures to be added to *AMedP-8(C)* to incorporate the five new agents. These addenda to *AMedP-8(C)* include the addition of agent-specific assumptions to *AMedP-8(C)* Chapter 1, survivor and non-survivor estimation descriptions to *AMedP-8(C)* Chapter 3, wounded in action (WIA) and died of wounds (DOW) calculation instructions to *AMedP-8(C)* Chapter 4, the infectivity and lethality submodel parameters and the tables derived for estimating WIAs and DOWs by day to *AMedP-8(C)* Annex A, and finally the parameters with accompanying figures and tables for the remaining submodels to *AMedP-8(C)* Annex C. To simplify the process of incorporating these sections into *AMedP-8(C)*, their content and format are consistent with the current chapters of that guide.

The scope of this document is limited to the substantial modifications to the content of *AMedP-8(C)* that will be made upon the inclusion of brucellosis, glanders, Q fever, staphylococcal enterotoxin B (SEB), and tularemia. Several editorial changes, such as renumbering figures and tables, updating the corresponding references in the text, and adding the appropriate new symbols to the list in Annex D, will also be required to account for the increased number of agents. Although it is important that these minor adjustments are made to *AMedP-8(C)*, for the sake of having a comprehensible and internally consistent document they are not the focus of this effort and will not be captured in this document.

2. *AMedP-8(C)* Chapter 1 Addenda

This chapter presents the addenda to *AMedP-8(C)* Chapter 1, namely the non-contagious biological agent assumptions and limitations. The first assumptions, which apply generally to all biological agents, should be added to Section 0106.7a, following paragraph 0106.7a(6).

(7) The methodology assumes that when human data are not available, human response parameters can be derived from animal models. Non-human primates are the animal model of choice unless otherwise stated.

(8) To simplify the model, a case fatality rate of 1% or below is considered negligible and a fatality rate of 0% is assumed. Similarly, in the absence of a well-quantified fatality rate, 100% lethality is assumed based on qualitative descriptions such as “highly lethal without treatment” or “nearly always fatal.”

The remaining paragraphs in this chapter describe the agent-specific assumptions and limitations for the new agents and should be added to the non-contagious biological agent explanation in Section 0106.7b, following the Venezuelan equine encephalitis (VEE) assumptions and limitations discussed in paragraph 0106.7b(3)(b).

(4) Brucellosis assumptions and limitations.

(a) Available case data from patients infected with different species of *Brucella* (*B. abortus*, *B. melitensis*, and *B. suis*) are similar enough that the human response is assumed to be the same following exposure to any of these species.

(b) The presentation and duration of brucellosis symptoms are assumed to be independent of the route of exposure. This assumption allows for the inclusion of a much larger body of data from which to characterize the injury profile and duration of illness submodels.

(c) In order to combine data reported in different units, one organism, one cell, and one colony forming unit (CFU) are assumed to be equivalent units.

(5) Glanders assumptions and limitations. Due to a lack of data from inhalation cases, the methodology assumes that the human response to *Burkholderia mallei* is independent of the route of exposure. Since aerosol exposures would likely result in symptoms that manifest earlier than those resulting from other routes of exposure, this assumption may result in a delayed reporting of casualties. In addition, this assumption may underestimate the number of fatalities, as inhalation glanders is thought to be more lethal than other forms.

(6) SEB assumptions and limitations.

(a) Consistent with the assumptions made for chemical agents, the methodology assumes SEB exposure to a 70 kg man. Since SEB intoxication is modeled for inhalation of a biotoxin, then (just as for chemical agents) this assumption may lead to an over- or underestimate of the number and severity of casualties.

(b) In the absence of lethal dose response data, the probit slope for SEB lethality was assumed to equal the probit slope for effectivity.

(7) Tularemia assumptions and limitations. Inhalation of *Francisella tularensis* is assumed to result in the pneumonic form of tularemia. Some of the most comprehensive clinical studies of tularemia available were reported in the pre-antibiotic era before inhalation was understood to be a potential route of infection; since pneumonic tularemia has been attributed to inhalation of the agent, untreated cases have been rare. Therefore, historical cases of typhoidal tularemia with pneumonia are assumed to provide the best available data to characterize lethality, injury profile, and duration of illness within the tularemia human response model.

3. *AMedP-8(C)* Chapter 3 Addenda

This chapter presents the addenda to *AMedP-8(C)* Chapter 3. The following paragraphs describe the agent-specific considerations for implementation of the general non-contagious biological human response approach and should be added to Section 0303.2c, following the VEE considerations discussed in paragraph 0303.2c(3).

(4) Brucellosis. Brucellosis is not modeled to be lethal in any case; therefore, E = S. Since F = 0, the brucellosis tables in Annex A do not consider fatalities. Because the disease manifests with an abrupt onset in approximately half of the cases and an insidious onset in the other half,[1] the methodology requires that the total number of persons who become ill (E) be split into two groups. One table in Annex A is used to calculate the daily rates of casualties for the 50% experiencing abrupt onset and another table is used for the 50% experiencing insidious onset.

(5) Glanders. Glanders is expected to result in both fatalities and survivors. Although there are separate injury profiles for the two groups, the profiles are the same through stage three (the most severe stage of disease), after which the survivors enter a chronic illness stage and the non-survivors die. Since the two profiles differ only after the highest severity is reached, only the total numbers of illnesses (E) and fatalities (F) are needed to calculate the rate of casualties by day, as described in Chapter 4.

(6) Q fever. Q fever is not modeled to be lethal in any case; therefore, E = S. Since F = 0, the Q fever tables in Annex A do not consider fatalities. Because the incubation period model selected for Q fever is dose-dependent, the estimated number of persons who become ill must first be binned according to the dose received to determine the number of casualties by day. This calculation is made for each dose range specified in Table A-58 by summing E_n, the number of people ill at Icon *n*, for all icons receiving doses in that range.

(7) SEB. SEB is expected to result in both fatalities and survivors. Since the injury profiles for SEB survivors and non-survivors both reach their maximum severity level during the first stage of illness and the two groups share a common incubation period, the total number of people ill (E) is sufficient to calculate the number of people ill by day as described in Chapter 4. To determine the number of fatalities by day, however, the total number of fatalities (F) must be binned by the received dose into the dose ranges specified in Table A-62. For each dose range, users must sum F_n, the number of fatalities at Icon *n*, for all icons receiving doses in that range.

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[1] Edward J. Young, "Human Brucellosis," *Reviews of Infectious Diseases* 5, no. 5 (1983): 821–42; Edward J. Young, "An Overview of Human Brucellosis," *Clinical Infectious Diseases* 21, no. 2 (1995): 283–89; and P. Bossi et al., "Bichat Guidelines for the Clinical Management of Brucellosis and Bioterrorism-Related Brucellosis," *Eurosurveillance* 9, no. 12 (2004): 1–5.

(8) Tularemia. Tularemia is expected to result in both fatalities and survivors. Like Q fever, the incubation period model for tularemia is dependent on dose, so both the estimated number of people ill (E) and the estimated number of fatalities (F) must be binned according to the dose ranges specified in Tables A-65 and A-66. Thus to determine the number of people ill within a dose range, users must sum E_n for all icons receiving doses in that range. Likewise, to determine the number of fatalities for a given dose range, users must sum F_n for all icons receiving doses in that range.

4. *AMedP-8(C)* Chapter 4 Addenda

The addenda to *AMedP-8(C)* Chapter 4, namely the agent-specific considerations for calculating the number of WIAs and DOWs per day are presented in this chapter. The following paragraphs should be added to Section 0405.4, following the VEE discussion in paragraph 0405.4c.

d. Brucellosis.

(1) WIA. As shown in Table A-47, abrupt onset brucellosis is modeled as a single stage disease with a "Severe" symptom severity level. Whether the WIA criterion is defined at the "Mild," "Moderate," or "Severe" severity level, the number of abrupt onset WIAs per day is obtained by multiplying the total number of persons experiencing abrupt onset by the values in Table A-49. Insidious onset brucellosis, on the other hand, is modeled as a two stage disease with increasing severity over time. Once users select the severity level that characterizes an individual as a casualty, Table A-48 is used to determine which stage of disease first meets or exceeds the chosen severity level for insidious onset brucellosis. The number of WIAs per day is calculated by multiplying the number of persons experiencing insidious onset by the values in either Table A-50 (if the WIA criterion is "Mild") or Table A-51 (if the WIA criterion is "Moderate" or "Severe"). The total number of WIAs per day is calculated by adding the daily estimates of WIAs resulting from both abrupt and insidious onset brucellosis cases.

(2) DOW. Brucellosis is assumed to result in no fatalities. Therefore no DOW estimate is made and no additional calculations are required.

e. Glanders.

(1) WIA. Once users select the severity level that characterizes an individual as a casualty, Table A-52 is used to determine which stage of disease first meets or exceeds the chosen severity level. The total number of persons who become ill (E) is then multiplied by the fractional value for each day in the appropriate table in Annex A (Table A-53 if the WIA criterion is "Mild," Table A-54 if the WIA criterion is "Moderate," or Table A-55 if the WIA criterion is "Severe") to determine the number of WIAs per day.

(2) DOW. The number of glanders fatalities per day is calculated by multiplying the estimated total number of non-survivors (F) by each day's value in Table A-56.

f. Q fever.

(1) WIA. As shown in Table A-57, Q fever is modeled as a one stage disease with a "Moderate" symptom severity level. If users select a severity level of "Severe" as the casualty criterion, then no one will meet that criterion and there will be no estimated WIAs. Alternatively, if the casualty criterion is chosen as "Mild" or "Moderate," then the number of WIAs per day is calculated using Table A-58. Since the incubation period is a deterministic dose-dependent model, Table A-58 contains dose ranges rather than fractions of the population that become WIA on each day. No computation is needed beyond binning people into the dose ranges specified in Table A-58; the number of people in each dose range is equal to the number of WIAs occurring on the corresponding day in the first column.

(2) DOW. Q fever is assumed to result in no fatalities. Therefore, no DOW estimate is made and no additional calculations are required.

g. SEB.

(1) WIA. As shown in Tables A-59 and A-60, the SEB survivor and non-survivor injury profiles both start with a symptom severity level of "Severe." Therefore, regardless of the casualty criterion, all individuals will be recorded as WIAs when they enter the first stage of illness. Since the incubation period is modeled to be the same for all people (nine hours), the total number of people (E) will be counted as WIAs on the day of the exposure, as indicated in Table A-61.

(2) DOW. Due to the dose-dependent model for the duration of illness, the time to death is a function of the dose of SEB inhaled. Once the estimated fatalities have been binned into the appropriate dose range in Table A-62, the number of people in each range is equal to the number of DOWs occurring on the corresponding day in the table's first column.

h. Tularemia.

(1) WIA. As shown in Tables A-63 and A-64, the tularemia survivor and non-survivor injury profiles both start with a symptom severity level of "Severe." Therefore, regardless of the casualty criterion, all individuals will be recorded as WIAs when they enter the first stage of illness. Since the incubation period is a deterministic dose-dependent model, Table A-65 contains dose ranges rather than fractions of the population that become WIA on each day. No computation is needed beyond binning people into the dose ranges specified in Table A-65; the number of people in each dose range is equal to the number of WIAs occurring on the corresponding day in the first column.

(2) DOW. Likewise, the number of fatalities per day is a function of the doses received by all individuals. Once the estimated fatalities have been binned into the appropriate dose range in Table A-66, the number of people in each range is equal to the number of DOWs occurring on the corresponding day in the table's first column.

5. *AMedP-8(C)* Annex A Addenda

This chapter presents the addenda to *AMedP-8(C)* Annex A. The following sections describe the parameters needed to implement the *AMedP-8(C)* methodology for the five additional biological agents and should be added to Section A108, following the VEE Section A108.3. The daily casualty tables for each agent were derived by convolving the time-based distributions representing the incubation period and the duration of illness according to the methods described in the *Technical Reference Manual: Allied Medical Publication 8(C), NATO Planning Guide for the Estimation of Chemical, Biological, Radiological, and Nuclear (CBRN) Casualties*.[2] These time-based distributions are described in detail in the next chapter.

A108.4 Brucellosis Parameters and Lookup Tables

1. Infectivity. The probability of becoming ill with brucellosis is modeled as a log-probit function with a probit slope of 2.58 probits/log(dose) and a median infectious dose (ID_{50}) of 949 organisms.[3] The infective dose of brucellosis can, therefore, be expressed as a random variable with a lognormal distribution whose cumulative distribution (CDF) is:

$$p_{\text{E-Bruc}}(\mathrm{d}_n) = \frac{1}{2} + \frac{1}{2} erf\left[\frac{\ln(\mathrm{d}_n) - \mu}{\sigma\sqrt{2}}\right]$$

where:

n is the index number of the icon,

$p_{\text{E-Bruc}}(\mathrm{d}_n)$ is the fraction of persons exposed to a dose d of *Brucella* organisms at Icon n who become ill (exposed and infected),

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2 Carl A. Curling et al., *Technical Reference Manual: Allied Medical Publication 8(C), NATO Planning Guide for the Estimation of Chemical, Biological, Radiological, and Nuclear (CBRN) Casualties*, IDA Document D-4082 (Alexandria, VA: Institute for Defense Analyses, June 2010).

3 Derived from data in Sanford S. Elberg et al., "Immunization against *Brucella* Infection IV: Response of Monkeys to Injection of a Streptomycin-Dependent Strain of *Brucella melitensis*," *The Journal of Bacteriology* 69, no. 6 (June 1955): 643–48; Sanford S. Elberg and W. K. Faunce, Jr., "Immunization against *Brucella* Infection 8. The Response of *Cynomolgus philippinensis*, Guinea-Pigs and Pregnant Goats to Infection by the Rev I Strain of *Brucella melitensis*," *Bulletin of the World Health Organization* 26, no. 3 (1962): 421–36.; Sanford S. Elberg and W.K. Faunce, Jr., "Immunization against *Brucella* Infection 10. The Relative Immunogenicity of *Brucella abortus* Strain 19-BA and *Brucella melitensis* Strain Rev I in *Cynomolgus philippinensis*," *Bulletin of the World Health Organization* 30, no. 5 (1964): 693–99; and M. G. Mense et al., "Pathologic Changes Associated with Brucellosis Experimentally Induced by Aerosol Exposure in Rhesus Macaques (*Macaca mulatta*)," *American Journal of Veterinary Research* 66, no. 5 (May 2004): 644–52.

d_n is the dose of *Brucella* at Icon *n* [organisms],

μ is the mean of the variable's natural logarithm [= ln(ID_{50} = ln(949 organisms) = 6.86],

m is the probit slope [= 2.58 probits/log(dose)]

σ is the standard deviation of the variable's natural logarithm [= $e^{1/m}$ = $e^{1/2.58}$ = 1.47], and

erf is the error function where $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt.$

Based on this distribution, Figure A-58 illustrates the probability of becoming ill from the dose of *Brucella* inhaled.

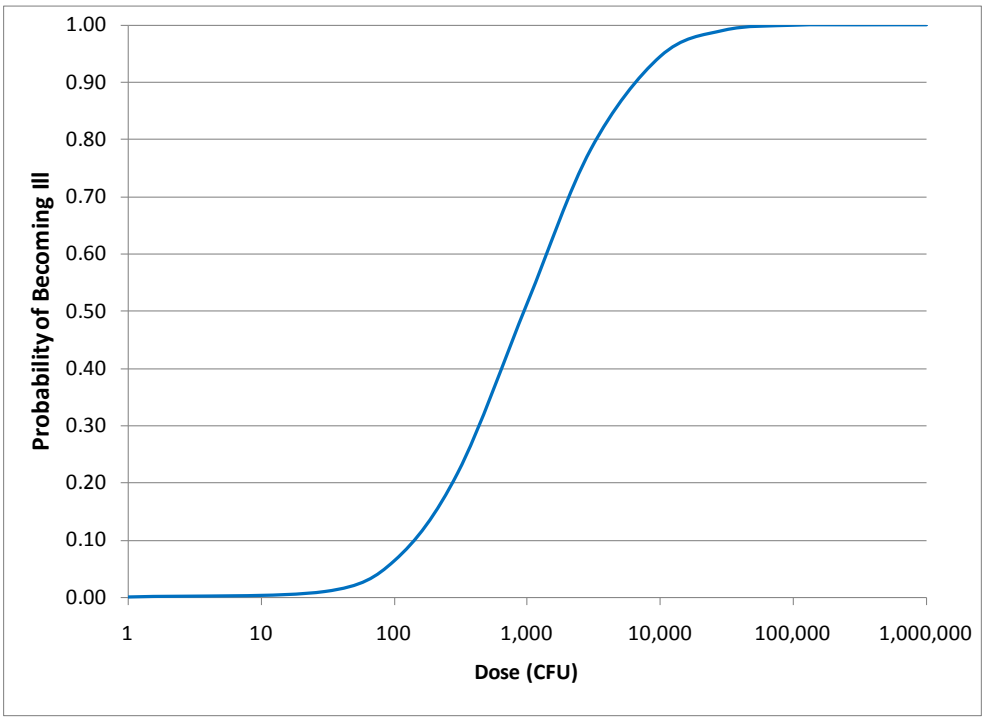

Figure A-58. Dose-Related Probability of Becoming Ill with Brucellosis

2. Lethality. For brucellosis, lethality is assumed to be 0%. Therefore $p_{\text{f-Bruc}}(d_n) = 0$ for all values of d_n, and there are no resulting DOW casualties.[4]

[4] Since the untreated case fatality rates are reportedly no greater than 6% (see first five references) and the reporting rate of brucellosis is less than 10% (see final two references), the percentage of individuals that die from brucellosis is likely less than 0.6% of the number who actually become ill. P. W. Bassett-Smith, "Mediterranean or Undulant Fever," *The British Medical Journal* 2, no. 3228 (1922): 902–5; Alice C. Evans, "Undulant Fever," *The American Journal of Nursing* 30, no. 11 (1930): 1349–52; Louise Hostman, "Undulant Fever," *The American Journal of Nursing* 34, no. 8 (1934): 753–58; Bossi et al., "Bichat Guidelines for the Clinical Management of Brucellosis;" Pablo Yagupsky and Ellen Jo Baron, "Laboratory Exposures to Brucellae and Implications for Bioterrorism," *Emerging Infectious Diseases* 11, no. 8 (2005): 1180–85; Robert I. Wise,

Table A-47. Injury Profile for Abrupt Onset Brucellosis

Stage	Sign/Symptom Severity Level
1	3

Table A-48. Injury Profile for Insidious Onset Brucellosis

Stage	Sign/Symptom Severity Level
1	1
2	3

"Brucellosis in the United States: Past, Present, and Future," *The Journal of American Medical Association* 244, no. 20 (1980): 2318; and Sascha Al Dahouk et al., "Changing Epidemiology of Human Brucellosis, Germany, 1962–2005," *Emerging Infectious Diseases* 13, no. 2 (2007): 1898.

Table A-49. Fraction of People Ill with Abrupt Onset Brucellosis Who Enter Stage 1 of Illness on Specified Day

Day	Stage 1 – Abrupt Onset	Day	Stage 1 – Abrupt Onset
1	0.0006	**63**	0.0712
2	0.0015	**70**	0.0661
3	0.0021	**77**	0.0602
4	0.0027	**84**	0.0538
5	0.0033	**91**	0.0473
6	0.0038	**98**	0.0409
7	0.0042	**105**	0.0348
8	0.0047	**112**	0.0293
9	0.0051	**119**	0.0242
10	0.0055	**126**	0.0198
11	0.0058	**133**	0.0160
12	0.0062	**140**	0.0128
13	0.0065	**147**	0.0101
14	0.0069	**154**	0.0079
15	0.0072	**161**	0.0061
16	0.0075	**168**	0.0046
17	0.0077	**175**	0.0035
18	0.0080	**182**	0.0026
19	0.0083	**189**	0.0019
20	0.0085	**196**	0.0014
21	0.0087	**203**	0.0010
22	0.0089	**210**	0.0007
23	0.0091	**217**	0.0005
24	0.0093	**224**	0.0004
25	0.0095	**231**	0.0003
26	0.0097	**238**	0.0002
27	0.0098	**245**	0.0001
28	0.0100	**252**	0.0001
35	0.0731	**259**	0.0001
42	0.0764	**266**	0.0000
49	0.0768	**273**	0.0000
56	0.0749	**280**	0.0000

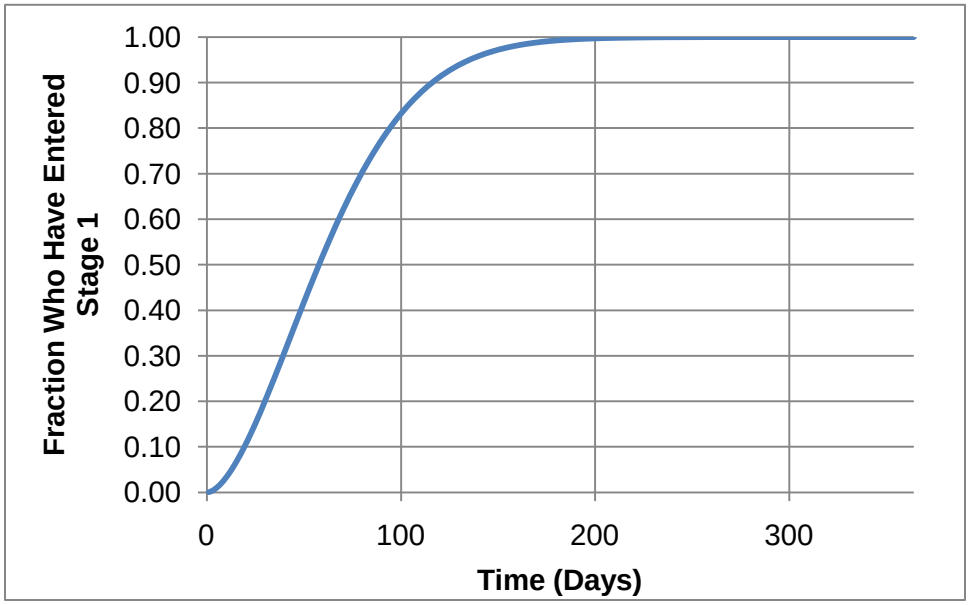

Figure A-59. Fraction of People Ill with Abrupt Onset Brucellosis Who Have Entered Stage 1 of Illness by Specified Day

Table A-50. Fraction of People Ill with Insidious Onset Brucellosis Who Enter Stage 1 of Illness on Specified Day

Day	Stage 1 – Insidious Onset	Day	Stage 1 – Insidious Onset
1	0.0006	**63**	0.0712
2	0.0015	**70**	0.0661
3	0.0021	**77**	0.0602
4	0.0027	**84**	0.0538
5	0.0033	**91**	0.0473
6	0.0038	**98**	0.0409
7	0.0042	**105**	0.0348
8	0.0047	**112**	0.0293
9	0.0051	**119**	0.0242
10	0.0055	**126**	0.0198
11	0.0058	**133**	0.0160
12	0.0062	**140**	0.0128
13	0.0065	**147**	0.0101
14	0.0069	**154**	0.0079
15	0.0072	**161**	0.0061
16	0.0075	**168**	0.0046
17	0.0077	**175**	0.0035
18	0.0080	**182**	0.0026
19	0.0083	**189**	0.0019
20	0.0085	**196**	0.0014
21	0.0087	**203**	0.0010
22	0.0089	**210**	0.0007
23	0.0091	**217**	0.0005
24	0.0093	**224**	0.0004
25	0.0095	**231**	0.0003
26	0.0097	**238**	0.0002
27	0.0098	**245**	0.0001
28	0.0100	**252**	0.0001
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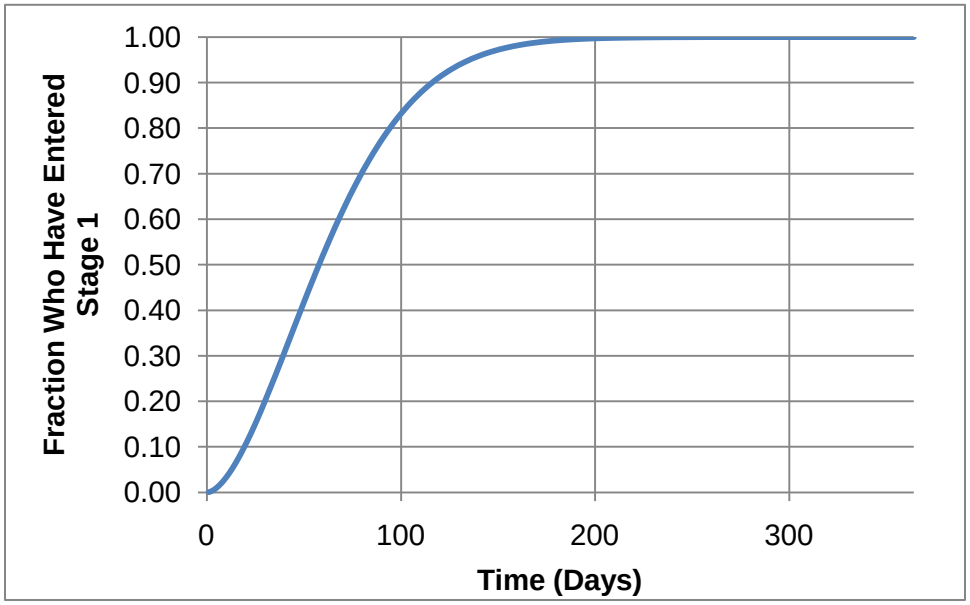

Figure A-60. Fraction of People Ill with Insidious Onset Brucellosis Who Have Entered Stage 1 of Illness by Specified Day

Table A-51. Fraction of People Ill with Insidious Onset Brucellosis Who Enter Stage 2 of Illness on Specified Day

Day	Stage 2 – Insidious Onset	Day	Stage 2 – Insidious Onset
1	0.0000	**105**	0.0503
2	0.0001	**112**	0.0463
3	0.0001	**119**	0.0421
4	0.0002	**126**	0.0377
5	0.0004	**133**	0.0336
6	0.0005	**140**	0.0297
7	0.0007	**147**	0.0258
8	0.0008	**154**	0.0227
9	0.0010	**161**	0.0196
10	0.0011	**168**	0.0166
11	0.0014	**175**	0.0143
12	0.0014	**182**	0.0120
13	0.0016	**189**	0.0101
14	0.0019	**196**	0.0085
15	0.0020	**203**	0.0069
16	0.0022	**210**	0.0059
17	0.0023	**217**	0.0050
18	0.0027	**224**	0.0041
19	0.0027	**231**	0.0036
20	0.0030	**238**	0.0028
21	0.0031	**245**	0.0023
22	0.0032	**252**	0.0019
23	0.0035	**259**	0.0015
24	0.0037	**266**	0.0013
25	0.0039	**273**	0.0011
26	0.0041	**280**	0.0009
27	0.0043	**287**	0.0007
28	0.0045	**294**	0.0006
35	0.0361	**301**	0.0005
42	0.0439	**308**	0.0004
49	0.0501	**315**	0.0003
56	0.0554	**322**	0.0003
63	0.0580	**329**	0.0003
70	0.0598	**336**	0.0002
77	0.0600	**343**	0.0001
84	0.0589	**350**	0.0001
91	0.0565	**357**	0.0001
98	0.0544	**364**	0.0001

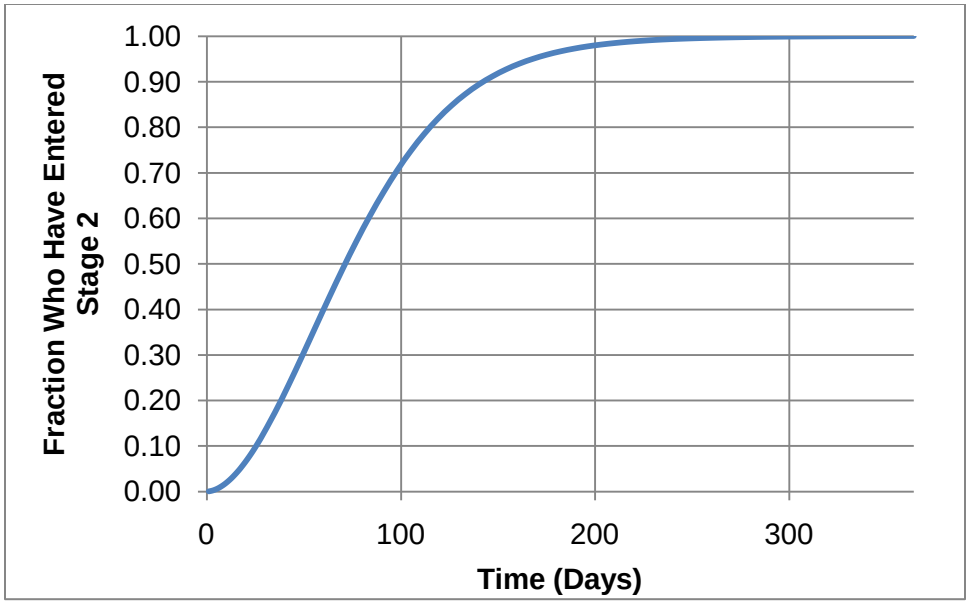

Figure A-61. Fraction of People Ill with Insidious Onset Brucellosis Who Have Entered Stage 2 of Illness by Specified Day

A108.5 Glanders Parameters and Lookup Tables

1. Infectivity. The probability of becoming ill with glanders is modeled as a log-probit function with a probit slope of 1.93 probits/log(dose) and a median infectious dose (ID_{50}) of 24.5 CFU.[5] The infective dose for glanders can, therefore, be expressed as a random variable with a lognormal distribution whose CDF is:

$$p_{\text{E-Glan}}(\mathrm{d}_n) = \frac{1}{2} + \frac{1}{2} erf\left[\frac{\ln(\mathrm{d}_n) - \mu}{\sigma\sqrt{2}}\right]$$

where:

n is the index number of the icon,

$p_{\text{E-Glan}}(\mathrm{d}_n)$ is the fraction of persons exposed to a dose d of *Burkholderia mallei* at Icon *n* who become ill (exposed and infected),

d_n is the dose of *Burkholderia mallei* [CFU],

μ is the mean of the variable's natural logarithm [= ln(ID_{50} = ln(24.5 CFU) = 3.20],

m is the probit slope [= 1.93 probits/log(dose)],

[5] George H. Anno et al., *Biological Agent Exposure and Casualty Estimation: AMedP-8 (Biological) Methods Report*, GS-35F-4923H (Fairfax, VA: General Dynamics Advanced Information Systems, May 2005).

σ is the standard deviation of the variable's natural logarithm [= $e^{1/m} = e^{1/1.93} = 1.68$], and

erf is the error function where $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt$.

Figure A-62 illustrates the probability of becoming ill from the dose of *Burkholderia mallei* inhaled.

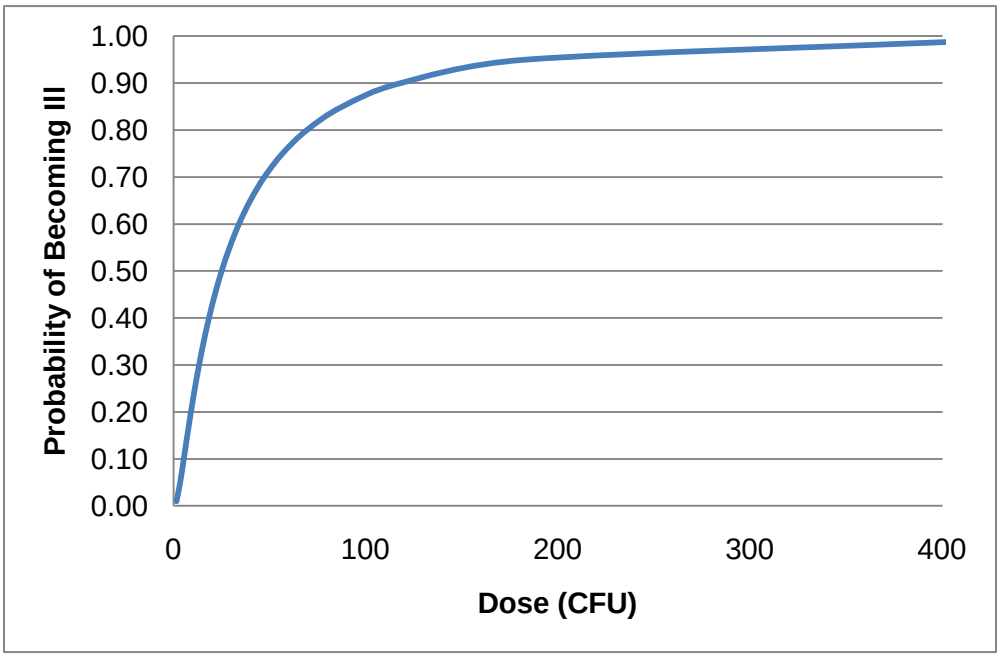

Figure A-62. Dose-Related Probability of Becoming Ill with Glanders

2. Lethality. The untreated case fatality rate for individuals ill with glanders is approximately 70%.[6] A lethality rate of 70% will, therefore, be modeled for glanders, so $p_{f\text{-}Glan}(d_n) = 0.70 * p_{E\text{-}Glan}(d_n)$.

[6] Derived from data in John Elliotson, "On the Glanders in the Human Subject," *Journal of the Royal Society of Medicine* 16, Pt. 1 (1831): 171–218; Clement Hamerton, "Cases of Acute Glanders in the Human Subject, Terminating Fatally," *Dublin Journal of Medical Science* 23, no. 3 (1843); W. I. Cox, "Case of Acute Glanders in the Human Subject: With Remarks," *British Medical Journal* 2, no. 66 (1854): 309–12; Frederick Mason, "Case of Glanders in Man," *Association Medical Journal* 4, no. 168 (1856): 232–34; J. Clark Stewart, "Pyæmic Glanders in the Human Subject: Report of a Recent Case of Laboratory Origin Terminating in Recovery," *Annals of Surgery* 40, no. 1 (1904): 109–13; George Dougall Robins, *A Study of Chronic Glanders in Man with Report of a Case: Analysis of 156 Cases Collected from the Literature and an Appendix of the Incidence of Equine and Human Glanders in Canada* Vol. 2, No. 1, Studies from the Royal Victoria Hospital Montreal (Montreal: Montreal Guertin Printing Co., 1906); James Taft Pilcher, "Glanders in the Human Subject," *Annals of Surgery* 45, no. 3 (1907): 444–52; William Hunting, *Glanders: A Clinical Treatise* (London: H. & W. Brown, 1908); Julius M. Bernstein and E. Rock Carling, "Observations on Human Glanders," *British Medical Journal* 1, no. 2510 (1909): 319–25; I. Sobol, "A Case of Chronic Nasal Glanders," *Acta Oto-Laryngologica* 18, no. 4 (1933): 500–9; J. F. Burgess, "Chronic Glanders," *Canadian Medical Association Journal* 34, no. 3 (1936): 258–62; and A. A. Herold and C. B. Erickson, "Human Glanders: Case Report," *Southern Medical Journal* 31, no. 9 (1938): 1022.

Table A-52. Injury Profile for Glanders

Stage	Sign/Symptom Severity Level
1	1
2	2
3	3
4 (survivors only)	2

Table A-53. Fraction of People Ill with Glanders Who Enter Stage 1 of Illness on Specified Day

Day	Stage 1	Day	Stage 1
1	0.0897	**35**	0.0171
2	0.1467	**42**	0.0100
3	0.1258	**49**	0.0062
4	0.1006	**56**	0.0041
5	0.0801	**63**	0.0028
6	0.0643	**70**	0.0019
7	0.0522	**77**	0.0014
8	0.0429	**84**	0.0010
9	0.0357	**91**	0.0008
10	0.0300	**98**	0.0006
11	0.0254	**105**	0.0005
12	0.0217	**112**	0.0004
13	0.0186	**119**	0.0003
14	0.0161	**126**	0.0002
15	0.0140	**133**	0.0002
16	0.0123	**140**	0.0002
17	0.0108	**147**	0.0001
18	0.0096	**154**	0.0001
19	0.0085	**161**	0.0001
20	0.0076	**168**	0.0001
21	0.0068	**175**	0.0001
22	0.0061	**182**	0.0001
23	0.0055	**189**	0.0000
24	0.0050	**196**	0.0000
25	0.0045	**203**	0.0000
26	0.0041	**210**	0.0000
27	0.0037	**217**	0.0000
28	0.0034	**224**	0.0000

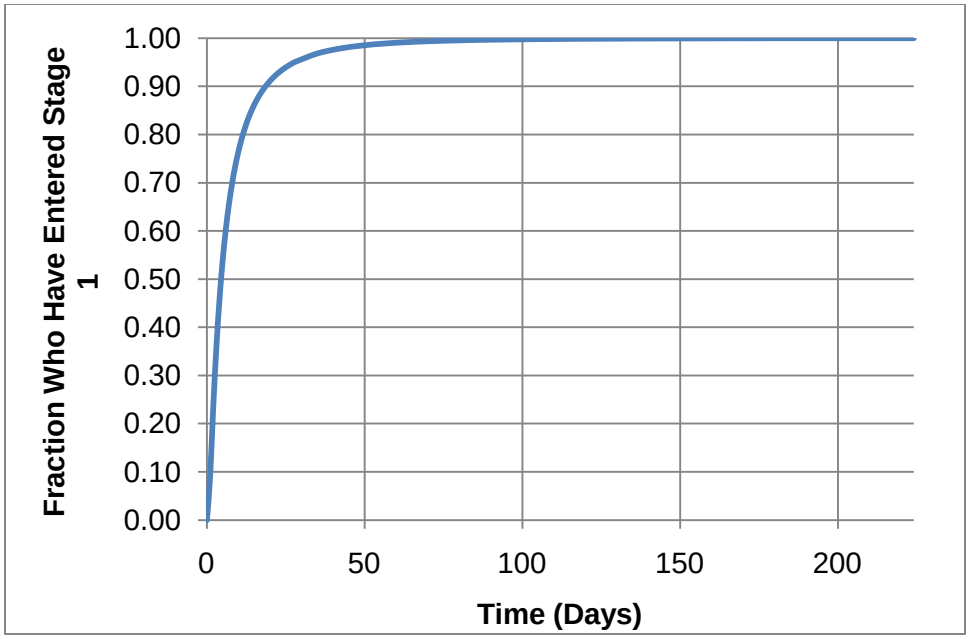

Figure A-63. Fraction of People Ill with Glanders Who Have Entered Stage 1 of Illness by Specified Day

Table A-54. Fraction of People Ill with Glanders Who Enter Stage 2 of Illness on Specified Day

Day	Stage 2	Day	Stage 2
1	0.0003	**35**	0.0358
2	0.0039	**42**	0.0183
3	0.0119	**49**	0.0104
4	0.0227	**56**	0.0064
5	0.0343	**63**	0.0042
6	0.0453	**70**	0.0028
7	0.0544	**77**	0.0020
8	0.0611	**84**	0.0014
9	0.0650	**91**	0.0011
10	0.0662	**98**	0.0008
11	0.0651	**105**	0.0006
12	0.0621	**112**	0.0005
13	0.0578	**119**	0.0004
14	0.0526	**126**	0.0003
15	0.0471	**133**	0.0002
16	0.0416	**140**	0.0002
17	0.0363	**147**	0.0002
18	0.0315	**154**	0.0001
19	0.0272	**161**	0.0001
20	0.0234	**168**	0.0001
21	0.0202	**175**	0.0001
22	0.0174	**182**	0.0001
23	0.0150	**189**	0.0001
24	0.0131	**196**	0.0000
25	0.0114	**203**	0.0000
26	0.0100	**210**	0.0000
27	0.0088	**217**	0.0000
28	0.0078	**224**	0.0000

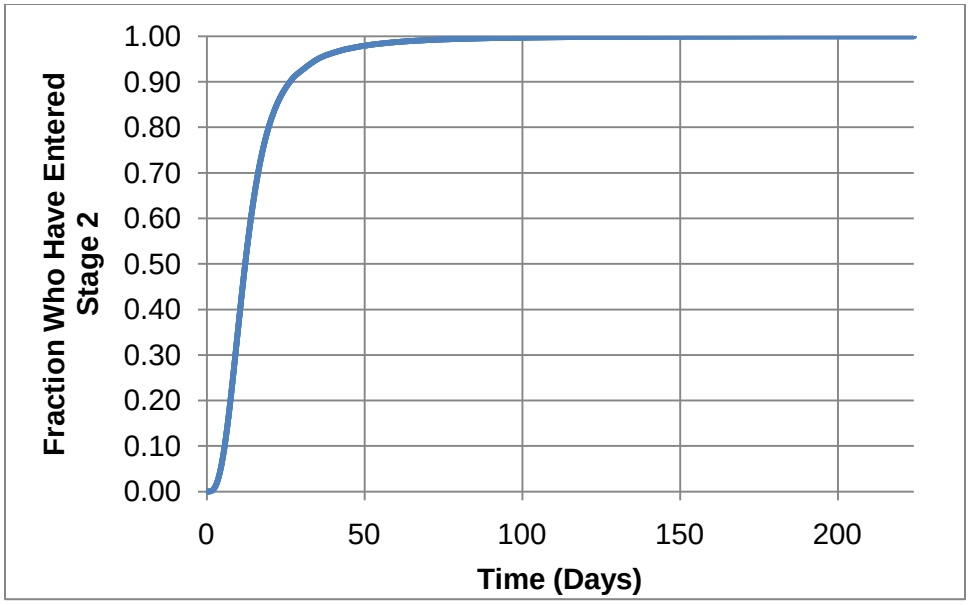

Figure A-64. Fraction of People Ill with Glanders Who Have Entered Stage 2 of Illness by Specified Day

Table A-55. Fraction of People Ill with Glanders Who Enter Stage 3 of Illness on Specified Day

Day	Stage 3	Day	Stage 3
1	0.0001	**35**	0.1525
2	0.0007	**42**	0.0884
3	0.0022	**49**	0.0459
4	0.0043	**56**	0.0230
5	0.0069	**63**	0.0120
6	0.0097	**70**	0.0068
7	0.0126	**77**	0.0042
8	0.0156	**84**	0.0028
9	0.0185	**91**	0.0019
10	0.0213	**98**	0.0014
11	0.0239	**105**	0.0010
12	0.0263	**112**	0.0007
13	0.0284	**119**	0.0006
14	0.0303	**126**	0.0004
15	0.0318	**133**	0.0003
16	0.0330	**140**	0.0003
17	0.0339	**147**	0.0002
18	0.0345	**154**	0.0002
19	0.0348	**161**	0.0001
20	0.0348	**168**	0.0001
21	0.0345	**175**	0.0001
22	0.0341	**182**	0.0001
23	0.0334	**189**	0.0001
24	0.0325	**196**	0.0001
25	0.0314	**203**	0.0001
26	0.0303	**210**	0.0000
27	0.0290	**217**	0.0000
28	0.0276	**224**	0.0000

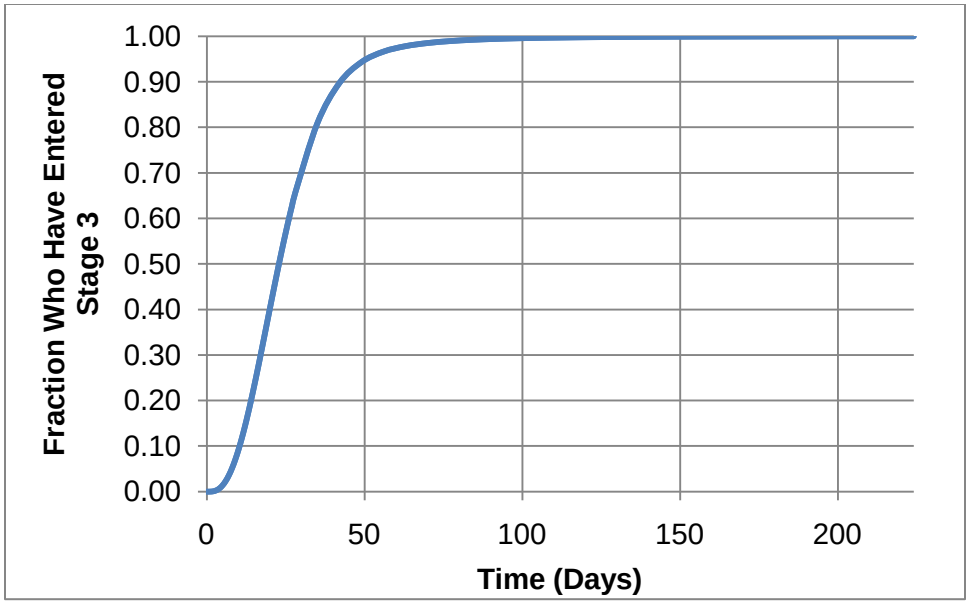

Figure A-65. Fraction of People Ill with Glanders Who Have Entered Stage 3 of Illness by Specified Day

Table A-56. Fraction of Non-Survivors Ill with Glanders Who Die on Specified Day

Day	DOW	Day	DOW
1	0.0000	**35**	0.1709
2	0.0004	**42**	0.1298
3	0.0013	**49**	0.0869
4	0.0025	**56**	0.0528
5	0.0040	**63**	0.0301
6	0.0057	**70**	0.0166
7	0.0075	**77**	0.0092
8	0.0094	**84**	0.0053
9	0.0112	**91**	0.0033
10	0.0131	**98**	0.0021
11	0.0149	**105**	0.0015
12	0.0166	**112**	0.0011
13	0.0183	**119**	0.0008
14	0.0198	**126**	0.0006
15	0.0212	**133**	0.0005
16	0.0225	**140**	0.0004
17	0.0237	**147**	0.0003
18	0.0247	**154**	0.0002
19	0.0255	**161**	0.0002
20	0.0262	**168**	0.0001
21	0.0268	**175**	0.0001
22	0.0272	**182**	0.0001
23	0.0274	**189**	0.0001
24	0.0276	**196**	0.0001
25	0.0276	**203**	0.0001
26	0.0274	**210**	0.0001
27	0.0272	**217**	0.0000
28	0.0268	**224**	0.0000

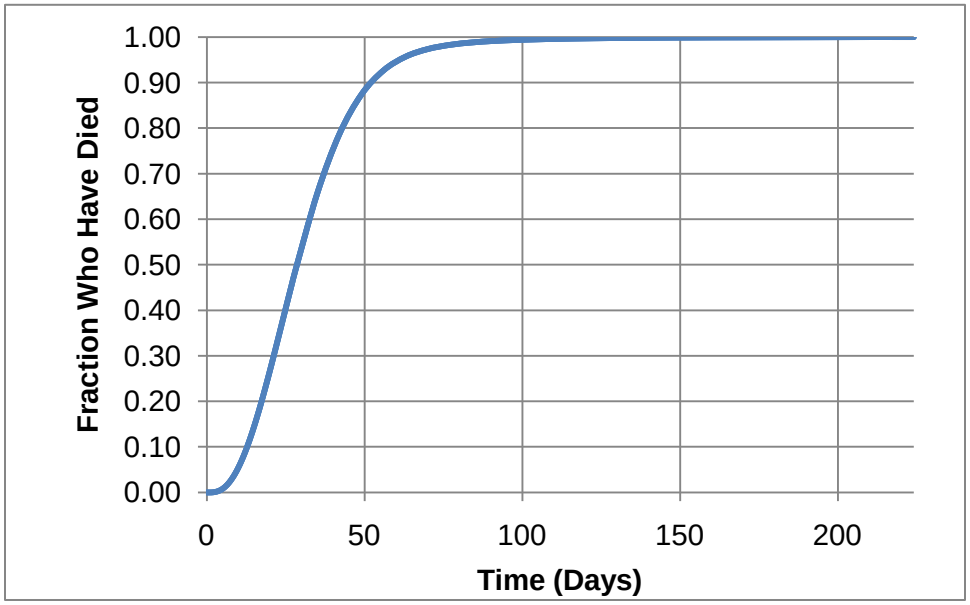

Figure A-66. Fraction of People Ill with Glanders Who Have Died by Specified Day

A108.6 Q Fever Parameters and Lookup Tables

1. Infectivity. The probability of becoming ill with Q fever is modeled as a log-probit function with a probit slope of 0.782 probits/log(dose) and a median infectious dose (ID_{50}) of 30 organisms.[7] The infectious dose for glanders can, therefore, be expressed as a random variable with a lognormal distribution whose CDF is:

$$p_{\text{E-Q-Fev}}(\mathrm{d}_n) = \frac{1}{2} + \frac{1}{2} erf\left[\frac{\ln(\mathrm{d}_n) - \mu}{\sigma\sqrt{2}}\right]$$

where:

n is the index number of the icon,

$P_{\text{E-Q-Fev}}$ (d_n) is the fraction of persons exposed to a dose d of *Coxiella burnetii* at Icon *n* who become ill (exposed and infected),

d_n is the dose of *Coxiella burnetii* [organisms],

[7] Derived from data in W. D. Tigertt and A.S. Benenson, "Studies on Q Fever in Man," *Transactions of the Association of American Physicians* 69 (1956): 98-104. The unit of guinea pig injected ID_{50} was converted to organisms using a factor of 1:2 reported in R. M. Ormsbee et al., "Limits of Rickettsial Infectivity," *Infection and Immunity* 19, no. 1 (January 1978): 239–45.

μ is the mean of the variable's natural logarithm [= ln(ID_{50} = ln(30 organisms) = 3.40],

m is the probit slope [= 0.782 probits/log(dose)],

σ is the standard deviation of the variable's natural logarithm [= $e^{1/m} = e^{1/0.782}$ = 3.59], and

erf is the error function where $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt.$

Figure A-67 illustrates the probability of becoming ill from the dose of *Coxiella burnetii* inhaled.

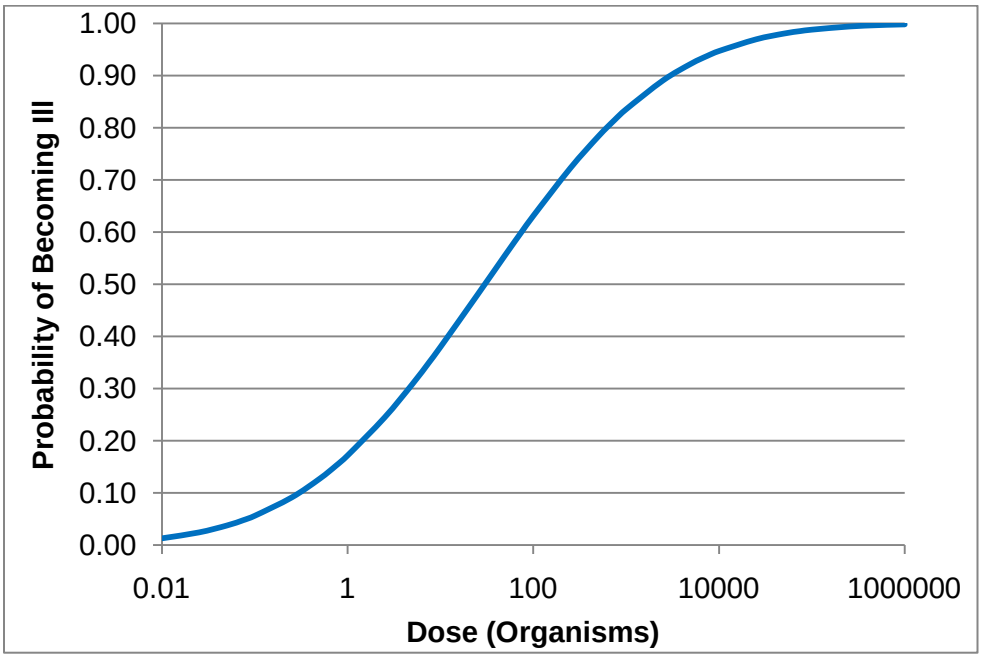

Figure A-67. Dose-Related Probability of Becoming Ill with Q Fever

2. Lethality. Q fever is assumed to be 0% lethal.[8] Therefore $p_{\text{f-Q-Fev}}(d_n) = 0$ for all values of d_n, and there are no resulting DOW casualties.

Table A-57. Injury Profile for Q Fever

Stage	Sign/Symptom Severity Level
1	2

[8] Assumption based on a 1–2% lethality rate and a statement of the underreporting of the disease reported in M. Maurin and D. Raoult, "Q Fever," *Clinical Microbiology Reviews* 12, no. 4 (October 1999): 518–53.

Table A-58. Number of People Ill with Q Fever Who Enter Stage 1 of Illness on Specified Day

Day	Dose Range (Organisms) >	Dose Range (Organisms) ≤	Number of People In Dose Range
20	0	2	
19	2	7	
18	7	24	
17	24	82	
16	82	279	
15	279	952	
14	952	3240	
13	3240	11029	
12	11029	37537	
11	37537	127756	
10	127756	434808	
9	434808	1479833	
8	1479833	5036486	
7	5036486	17141252	
6	17141252	58338793	
5	58338793	198551119	
4	198551119	675751835	
3	675751835	2299863853	
2	2299863853	7827390868	
1	7827390868		

A108.7 SEB Parameters and Lookup Tables

1. Effectivity. The probability of becoming ill with SEB intoxication is modeled as a log-probit function with a probit slope of 2.44 probits/log(dose)[9] and a median effective dose (ED_{50}) of 0.026 µg/man.[10] The effective dose of SEB can, therefore, be expressed as a random variable with a lognormal distribution whose CDF is:

$$p_{\text{E-SEB}}(\mathrm{d}_n) = \frac{1}{2} + \frac{1}{2} erf\left[\frac{\ln(\mathrm{d}_n) - \mu}{\sigma\sqrt{2}}\right]$$

9 Converted from a probit slope of 1.061 probits/ln dose reported in Anno et al., *AMedP-8 (Biological) Methods Report*, 94.

10 Anno et al., *AMedP-8 (Biological) Methods Report*, 94.

where:

n is the index number of the icon,

$p_{\text{E-SEB}}(d_n)$ is the fraction of persons exposed to a dose d of SEB at Icon *n* who become ill (exposed and infected),

d_n is the dose of SEB [µg/man],

µ is the mean of the variable's natural logarithm [= ln(ED_{50} = ln(0.026 µg/man) = -3.65],

m is the probit slope [= 2.44 probits/log(dose)],

σ is the standard deviation of the variable's natural logarithm [= $e^{1/m} = e^{1/2.44}$ = 1.51], and

erf is the error function where $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt.$

Figure A-68 illustrates the probability of becoming ill from the dose of SEB inhaled.

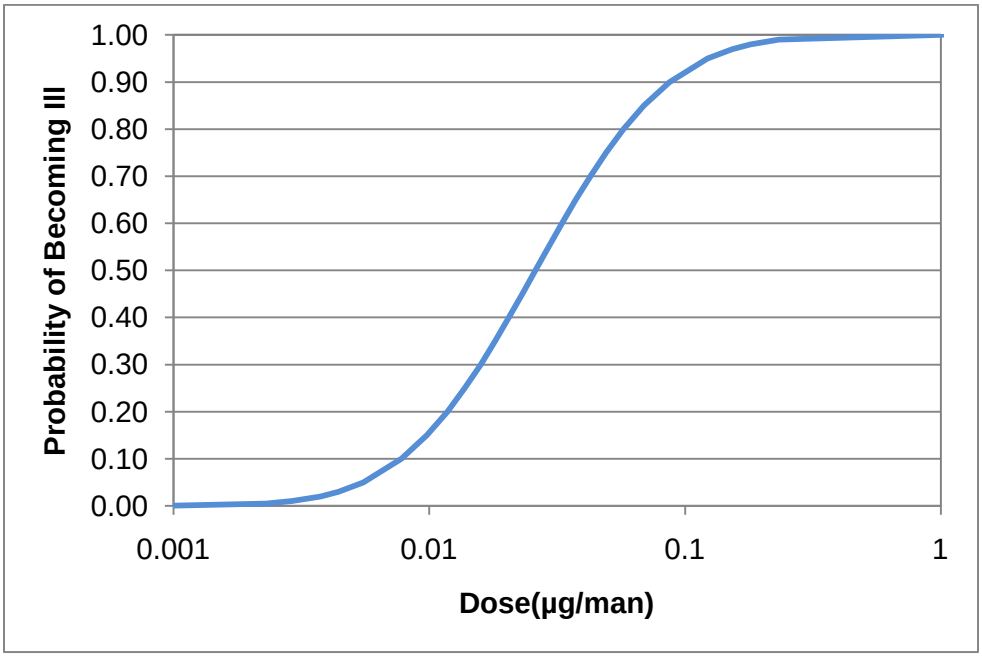

Figure A-68. Dose-Related Probability of Becoming Ill with SEB Intoxication

2. Lethality. SEB lethality is modeled as a log-probit function with a probit slope of 2.44 probits/log(dose)[11] and a median lethal dose (LD_{50}) of 1.4 µg/man.[12] The lethal dose of SEB can, therefore, be expressed as a random variable with a lognormal distribution whose CDF is:

$$p_{\text{f-SEB}}(\mathrm{d}_n) = \frac{1}{2} + \frac{1}{2} erf\left[\frac{\ln(\mathrm{d}_n) - \mu}{\sigma\sqrt{2}}\right]$$

where:

n is the index number of the icon,

$p_{\text{f-SEB}}(\mathrm{d}_n)$ is the fraction of persons exposed to a dose d of SEB at Icon *n* who die,

d_n is the dose of SEB [µg/man],

µ is the mean of the variable's natural logarithm [= $\ln(LD_{50} = \ln(1.4$ µg/man) = 0.336],

m is the probit slope [= 2.44 probits/log(dose)],

σ is the standard deviation of the variable's natural logarithm [= $e^{1/m} = e^{1/2.44} = 1.51$], and

erf is the error function where $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt$.

Figure A-69 illustrates the probability of dying from the dose of SEB inhaled.

[11] Assumed equal to the effectivity dose response probit slope.

[12] Assuming a 70 kg man, this value was calculated from the median lethal dose value reported in Janice M. Rusnak et al., "Laboratory Exposures to Staphylococcal Enterotoxin B," *Emerging Infectious Diseases* 10, 1548.

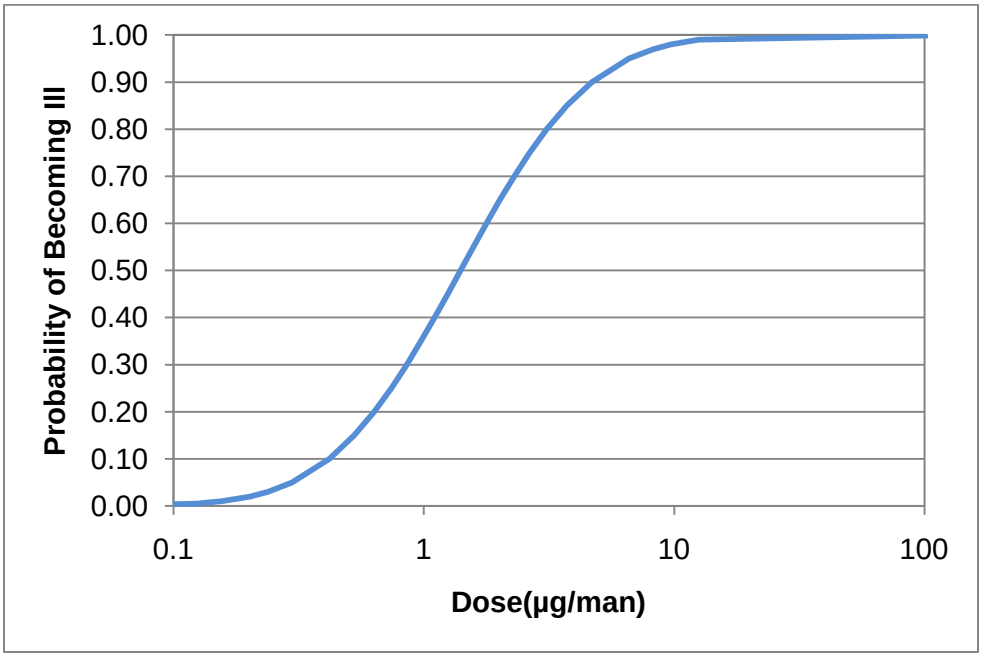

Figure A-69. Dose-Related Probability of Death from SEB Intoxication

Table A-59. Injury Profile for SEB Survivors

Stage	Sign/Symptom Severity Level
1	3
2	1

Table A-60. Injury Profile for SEB Non-Survivors

Stage	Sign/Symptom Severity Level
1	3

Table A-61. Fraction of People Ill with SEB Intoxication Who Enter Stage 1 of Illness on Specified Day

Day	Stage 1
1	1
>1	0

Table A-62. Fraction of Non-Survivors Ill with SEB Intoxication Who Die on Specified Day

	Dose Range (µg/man)		
Day	>	≤	Number of Non-Survivors In Dose Range
1	0	0.0239	
2	0.0239	0.0885	
3	0.0885	0.1532	
4	0.1532	0.2178	
5	0.2178	0.2824	
6	0.2824	0.3470	
7	0.3470	0.4116	
8	0.4116	0.4762	
9	0.4762		

A108.8 Tularemia Parameters and Lookup Tables

1. Infectivity. The probability of becoming ill with tularemia is modeled as a log-probit function with a probit slope of 1.90 probits/log(dose) and a median infectious dose (ID_{50}) of 10 organisms. The infectious dose of *Francisella tularensis* can, therefore, be expressed as a random variable with a lognormal distribution whose CDF is:

$$p_{\text{E-Tul}}(d_n) = \frac{1}{2} + \frac{1}{2} erf\left[\frac{\ln(d_n) - \mu}{\sigma\sqrt{2}}\right]$$

where:

n is the index number of the icon,

$p_{\text{E-Tul}}(d_n)$ is the fraction of persons exposed to a dose d of *Francisella tularensis* at Icon n who become ill (exposed and infected),

d_n is the dose of *Francisella tularensis* [organisms],

µ is the mean of the variable's natural logarithm [= ln(ID_{50} = ln(10 organisms) = 2.30],

m is the probit slope [= 1.90 probits/log(dose)],

σ is the standard deviation of the variable's natural logarithm [= $e^{1/m} = e^{1/1.90} = 1.69$], and

erf is the error function where $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt$.

Figure A-70 illustrates the probability of becoming ill from the dose of *Francisella tularensis* inhaled.

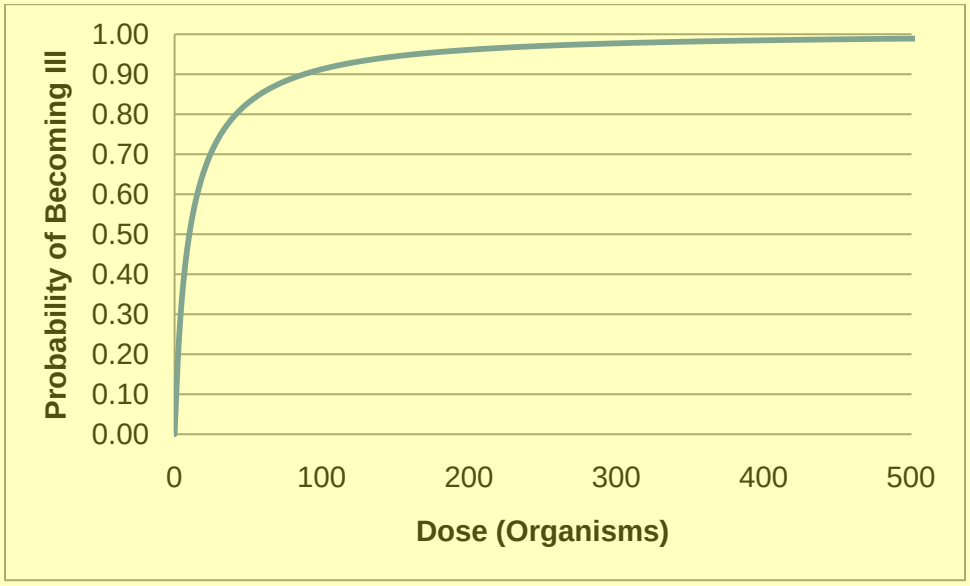

Figure A-70. Dose-Related Probability of Becoming Ill with Tularemia

2. Lethality. The untreated case fatality rate for individuals ill with tularemia is approximately 75%.[13] A lethality rate of 75% will therefore be modeled for tularemia, so $p_{f\text{-}Tul}(d_n) = 0.75 * p_{E\text{-}Tul}(d_n)$.

Table A-63. Injury Profile for Tularemia Survivors

Stage	Sign/Symptom Severity Level
1	3
2	3
3	2

[13] Based on the case fatality rate for typhoidal patients with pneumonia (6 of 8) from Roscoe L. Pullen and Byron M. Stuart, "Tularemia: Analysis of 225 Cases," *Journal of the American Medical Association* 129 no. 7 (1945): 495–500.

Table A-64. Injury Profile for Tularemia Non-Survivors

Stage	Sign/Symptom Severity Level
1	3
2	4

Table A-65. Number of People Ill with Tularemia Who Enter Stage 1 of Illness on Specified Day

Day	Dose Range (Organisms) >	Dose Range (Organisms) ≤	Number of People In Dose Range
7	0	4	
6	4	75	
5	75	1241	
4	1241	20502	
3	20502	421696	
2	421696		

Table A-66. Fraction of Non-Survivors Ill with Tularemia Who Die on Specified Day

Day	Dose Range (Organisms) >	Dose Range (Organisms) ≤	Number of Non-Survivors In Dose Range
22	0	4	
21	4	75	
20	75	1241	
19	1241	20502	
18	20502	421696	
17	421696		

6. *AMedP-8(C)* Annex C Addenda

This chapter presents the addenda to *AMedP-8(C)* Annex C. The specific distributions and parameters chosen for each of the five submodels for the five additional agents are presented in the following sections, which should be added to Annex C, following Section C128 "VEE Model Parameters." Subsequent sections should be renumbered accordingly.

C129 Brucellosis Model Parameters

Table C-53. Brucellosis Model Parameters Summary Table

Submodel	Type	Parameters
Infectivity	Lognormal distribution	ID_{50} = 949 organisms, Probit slope = 2.58 probits/log(dose)
Incubation period	Weibull distribution	α = 1.72, β = 10.2
Lethality, if symptomatic	Rate	0%
Duration of illness		
Total	Gamma distribution	k = 3.97, θ = 2.54
Abrupt onset Stage 1	Same as total	
Insidious onset Stage 1	Gamma distribution	k = 0.827, θ = 5.32
Insidious onset Stage 2	Total minus Stage 1	

1. Infectivity. The infectious dose of *Brucella* organisms is modeled as a log-probit function with a probit slope of 2.58 probits/log(dose) and an ID_{50} of 949 organisms (see Section A108.4).

2. Incubation period. The time spent in the incubation period for brucellosis is modeled as a random variable with a Weibull distribution whose CDF is:

$$F_{\text{Inc-Bruc}}(t) = 1 - e^{-(t/\beta)^{\alpha}}$$

where:

$F_{\text{Inc-Bruc}}$ is the cumulative fraction of persons with brucellosis who have completed the incubation period and entered Stage 1 of the disease,

t is the time post exposure [weeks],

α is the shape parameter [= 1.72], and

β is the scale parameter [= 10.2].[14]

3. Lethality. Brucellosis is modeled as non-lethal. Therefore, $p_{\text{f-Bruc}}(d_n) = 0$ for all values of d_n.

4. Injury profile. Distinct brucellosis injury profiles exist for those experiencing an abrupt symptom onset and those experiencing an insidious onset. Each injury profile characterizes the symptomatic period of illness and divides this period into different stages. For abrupt onset brucellosis, there is only one stage, whereas insidious onset brucellosis is modeled with two stages of illness. The signs and symptoms characterizing each stage as well as the corresponding sign/symptom severity level for each stage are described in Tables C-54 and C-55.[15] The duration of each stage is determined by the "duration of illness" models discussed in the following section.

[14] Derived from data in Robert W. Trever et al., "Brucellosis I. Laboratory-Acquired Acute Infection," *American Medical Association Archives of Internal Medicine* 103, no. 3 (March 1959): 381–97; Young, "Human Brucellosis;" Jaime E. Olle-Goig and Jaime Canela-Soler, "An Outbreak of *Brucella melitensis* by Airborne Transmission Among Laboratory Workers," *American Journal of Public Health* 77, no. 3 (March 1987): 335–38; Abdul Karim Al-Aska and Abdul Hamid Chagla, "Laboratory-Acquired Brucellosis," *Journal of Hospital Infection* 14, no. 1 (1989): 70–71; J. Staszkiewicz et al., "Outbreak of *Brucella melitensis* among Microbiology Laboratory Workers in a Community Hospital," *Journal of Clinical Microbiology* 29, no. 2 (February 1991): 287–90; E. Gruner et al., "Brucellosis: An Occupational Hazard for Medical Laboratory Personnel: Report of Five Cases," *Infection* 22, no. 1 (1994): 33–36; Pier-Luigi Fiori et al., "*Brucella abortus* Infection Acquired in Microbiology Laboratories," *Journal of Clinical Microbiology* 38, no. 5 (May 2000): 2005–6; Ziad A. Memish and M. W. Mah, "Brucellosis in Laboratory Workers at a Saudi Arabian Hospital," *American Journal of Infection Control* 29, no. 1 (2001): 48–52; Stephanie Noviello et al., "Laboratory-Acquired Brucellosis," *Emerging Infectious Diseases* 10, no. 10 (2004): 1848–50; Sophie Robichaud et al., "Prevention of Laboratory-Acquired Brucellosis," *Clinical Infectious Diseases* 38, no. 12 (June 15, 2004): e119–22; and Tuna Demirdal and Nese Demirturk, "Laboratory-Acquired Brucellosis," *Annals Academy of Medicine* 37, no. 1 (2008): 86–87.

[15] Derived from descriptions of brucellosis found in Bret K. Purcell, David L. Hoover, and Arthur M. Friedlander, "Brucellosis," in *Medical Aspects of Biological Warfare*, ed. Zygmunt F. Dembek, *Textbooks of Military Medicine* (Washington, DC: Department of Defense, Office of the Surgeon General, U.S. Army, Borden Institute, 2007): 185–98; and Anno et al., *AMedP-8 (Biological) Methods Report*.

Table C-54. Brucellosis Abrupt Onset Injury Profile

	Stage 1
Signs and Symptoms (S/S)	Fever, sweats, chills, headache, malaise, fatigue, arthralgia, myalgia, anorexia, weight loss.
S/S Severity	3 (Severe)
Outlook	Individual will likely recover from illness.

Table C-55. Brucellosis Insidious Onset Injury Profile

	Stage 1	Stage 2
Signs and Symptoms (S/S)	Fever, malaise.	Fever, sweats, chills, headache, malaise, fatigue, arthralgia, myalgia, anorexia, weight loss.
S/S Severity	1 (Mild)	3 (Severe)
Outlook	Individual will progress to Stage 2.	Individual will likely recover from illness.

5. Duration of illness.

a. The total duration of illness is modeled the same for both abrupt and insidious onset brucellosis cases. The total symptomatic period for brucellosis is modeled as a gamma-distributed random variable with median and mean values of 9.2 and 10.1 weeks, respectively, such that the cumulative fraction of persons becoming asymptomatic is:

$$F_{\text{Tot-Bruc}_{\mathbf{Abr}}}(t) = F_{\text{Tot-Bruc}_{\text{Ins}}}(t) = \sum_{i=k}^{\infty} \frac{(t/\theta)^i}{i!} e^{-t/\theta}$$

where:

$F_{\text{Tot-Bruc}_{\mathbf{Abr}}}$ is the cumulative fraction of persons with abrupt onset brucellosis who become asymptomatic,

$F_{\text{Tot-Bruc}_{\text{Ins}}}$ is the cumulative fraction of persons with insidious onset brucellosis who become asymptomatic,

t is the total duration of illness [weeks],

k is the shape parameter [= 3.97], and

θ is the scale parameter [= 2.54].[16]

b. Likewise, the duration of the first stage of insidious onset brucellosis is modeled as a gamma-distributed random variable with median and mean values of 2.8 and 4.4 weeks, respectively, such that the cumulative fraction of persons who complete Stage 1 is:

$$F_{\text{Stg1-Bruc}_{\text{Ins}}}(t) = \sum_{i=k}^{\infty} \frac{(t/\theta)^i}{i!} e^{-t/\theta}$$

where:

$F_{\text{Stg1-Bruc}_{\text{Ins}}}$ is the cumulative fraction of ill persons with insidious onset brucellosis who have completed Stage 1 and entered Stage 2,

t is the time since completing the incubation period and entering Stage 1 [weeks],

k is the shape parameter [= 0.827], and

θ is the scale parameter [= 5.32].[17]

c. The second stage of illness for insidious onset brucellosis is modeled as the difference between the total duration of illness and the duration of Stage 1.

6. Prophylaxis. No prophylaxis is modeled for brucellosis.

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16 Derived from data in Ruth Gilbert and Marion B. Coleman, "Undulant Fever in New York State," *The Journal of Infectious Diseases* 54, no. 3 (May–June, 1934): 305–12; George E. Atwood and H. E. Hasseltine, "Undulant Fever in Ware County, Ga," *Public Health Reports (1896–1970)* 45, no. 24 (June 13, 1930): 1343–54; and Geoffrey Shera, "Four Cases of Undulant Fever," *The British Medical Journal* 2, no. 3691 (October 3, 1931): 605–7.

17 Derived from data in Gilbert and Coleman, "Undulant Fever in New York State;" Atwood and Hasseltine, "Undulant Fever in Ware County, Ga;" Shera, "Four Cases of Undulant Fever;" and A. V. Hardy et al., "Undulant Fever," *Public Health Reports* 45, no. 41 (October 10, 1930): 2433–74.

C130 Glanders Model Parameters

Table C-56. Glanders Model Parameters Summary Table

Submodel	Type	Parameters
Infectivity	Lognormal distribution	ID_{50} = 24.5 CFU Probit slope = 1.93 probits/log(dose)
Incubation period	Lognormal distribution	Mean = 8.29 days Standard deviation = 13.0
Lethality, if symptomatic	Rate	70%
Duration of illness	Weibull distribution	α = 1.90 β = 26.0
Stage 1	Rate	30% of total duration
Stage 2	Rate	45% of total duration
Stage 3	Rate	25% of total duration

1. Infectivity. The infectious dose of *Burkholderia mallei* is modeled as a log-probit function with a probit slope of 1.93 probits/log(dose) and an ID_{50} of 24.5 CFU (see Section A108.5).

2. Incubation period. The time spent in the incubation period for glanders is modeled as a random variable with a lognormal distribution whose CDF is:

$$F_{\text{Inc-Glan}}(t) = \frac{1}{2} + \frac{1}{2} erf\left[\frac{\ln(t) - \mu}{\sigma\sqrt{2}}\right]$$

where:

$F_{\text{Inc-Glan}}$ is the fraction of persons exposed to a dose d of *Burkholderia mallei* at Icon *n* who become ill (exposed and infected),

t is the time post exposure [days],

M is the mean incubation period [= 8.29 days],

S is the standard deviation of the incubation periods [= 13.0 days],

μ is the mean of the variable's natural logarithm [$= \ln\left(\frac{M^2}{\sqrt{S^2+M^2}}\right) = \ln\left(\frac{8.29^2}{\sqrt{13.0^2+8.29^2}}\right)$ = 1.49],

σ is the standard deviation of the variable's natural logarithm [$= \sqrt{\ln\left(\left(\frac{S}{M}\right)^2 + 1\right)}$ $= \sqrt{\ln\left(\left(\frac{13.0}{8.29}\right)^2 + 1\right)}$ = 1.11], and

erf is the error function where $erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2}\, dt$.[18]

3. Lethality. Brucellosis is modeled with a case fatality rate of 70%. Therefore $p_{\text{f-Glan}}(d_n) = 0.70 * p_{\text{E-Glan}}(d_n)$.

4. Injury profile. The injury profiles for survivors and non-survivors of glanders are exactly the same through Stage 3. After progressing through Stage 3, the survivors enter a fourth stage of illness that is a milder, chronic form of glanders, while the non-survivors die. The signs and symptoms characterizing each stage, as well as the corresponding sign/symptom severity level for each stage, are described in Table C-57.

[18] Derived from data in Elliotson, "On the Glanders in the Human Subject;" John Elliotson, "Additional Facts Respecting Glanders in the Human Subject," *Journal of the Royal Society of Medicine* 18, Pt. 1 (1833): 201–7; Cox, "Case of Acute Glanders in the Human Subject: With Remarks;" Stewart, "Pyæmic Glanders in the Human Subject. Report of a Recent Case of Laboratory Origin Terminating in Recovery," Robins, *A Study of Chronic Glanders in Man with Report of a Case: Analysis of 156 Cases Collected from the Literature and an Appendix of the Incidence of Equine and Human Glanders in Canada*; Pilcher, "Glanders in the Human Subject;" Hunting, *Glanders: A Clinical Treatise*; Bernstein and Carling, "Observations on Human Glanders;" Herold and Erickson, "Human Glanders: Case Report;" Calderon Howe and Winston R. Miller, "Human Glanders: Report of Six Cases," *Annals of Internal Medicine* 26, no. 1 (1947): 93–115; and Arjun Srinivasan et al., "Glanders in a Military Research Microbiologist," *The New England Journal of Medicine* 345 (2001): 256–58.

Table C-57. Glanders Injury Profile

	Stage 1	Stage 2	Stage 3	Stage 4 (survivors)	Stage 4 (non-survivors)
Signs and Symptoms (S/S)	Localized pain and inflammation, fever, swelling, chills, and phlegmon.	Cough, suppuration, red streaks, papular eruption nasal discharge, abscess, pain, and ulcerations.	Diarrhea, emaciation, pustules, necrosis, dyspnea, and delirium.	Chronic glanders.	None (dead).
S/S Severity	1 (Mild)	2 (Moderate)	3 (Severe)	2 (Moderate)	
Outlook	Individual will progress to Stage 2.	Individual will progress to Stage 3.	Individual will progress to Stage 4.	Individual will likely recover after a prolonged illness.	Individual will likely die without treatment.

5. Duration of illness.

a. Since chronic effects are not considered in this document, the survivor duration of illness model spans only the acute phase of illness, i.e., the first three stages. Once survivors have progressed through Stage 3 and entered the chronic stage, they remain there for an indeterminate length of time. The "total" duration of illness, excluding the survivor Stage 4, is modeled to be the same as the total duration of illness for non-survivors, who progress through the same three stages as survivors before they die. The mean duration of the first three stages is modeled as a random variable with a Weibull distribution with a mean value of 23.1 days and a standard deviation of 12.7 days. The cumulative fraction of persons who complete Stage 3 is:

$$F_{\text{Stg3-Glan}}(t) = 1 - e^{-(t/\beta)^{\alpha}}$$

where:

$F_{Stg3\text{-}Glan}$ is the cumulative fraction of persons with glanders who have completed Stage 3,

t is the time since completing the incubation period and entering Stage 1 [days],

α is the shape parameter [= 1.90], and

β is the scale parameter [= 26.0].[19]

b. For both survivors and non-survivors, the time spent in each of the three stages is modeled to be proportional to the total time spent in all three stages. Individuals are modeled to spend 30% of the total duration in Stage 1, 45% of the total duration in Stage 2, and 25% of the total duration in Stage 3.[20]

6. Prophylaxis. No prophylaxis is modeled for glanders.

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19 Derived from data in Elliotson, "On the Glanders in the Human Subject;" Hamerton, "Cases of Acute Glanders in the Human Subject, Terminating Fatally;" Cox, "Case of Acute Glanders in the Human Subject: With Remarks;" Mason, "Case of Glanders in Man;" Stewart, "Pyæmic Glanders in the Human Subject. Report of a Recent Case of Laboratory Origin Terminating in Recovery;" Robins, *A Study of Chronic Glanders in Man with Report of a Case: Analysis of 156 Cases Collected from the Literature and an Appendix of the Incidence of Equine and Human Glanders in Canada*; Pilcher, "Glanders in the Human Subject;" Hunting, *Glanders: A Clinical Treatise*; Bernstein and Carling, "Observations on Human Glanders;" Sobol, "A Case of Chronic Nasal Glanders;" Burgess, "Chronic Glanders;" Herold and Erickson, "Human Glanders: Case Report;" and Howe and Miller, "Human Glanders: Report of Six Cases."

20 Derived from data in Hamerton, "Cases of Acute Glanders in the Human Subject, Terminating Fatally;" Cox, "Case of Acute Glanders in the Human Subject: With Remarks;" Mason, "Case of Glanders in Man;" Gordon Sharp, "The Morbid Anatomy of the Bones in Chronic Glanders in the Human Subject," *Journal of Anatomy* 29, Pt. 4 (1895): 492–93; Stewart, "Pyæmic Glanders in the Human Subject. Report of a Recent Case of Laboratory Origin Terminating in Recovery;" Robins, *A Study of Chronic Glanders in Man with Report of a Case: Analysis of 156 Cases Collected from the Literature and an Appendix of the Incidence of Equine and Human Glanders in Canada*; Pilcher, "Glanders in the Human Subject;" Hunting, *Glanders: A Clinical Treatise*; Bernstein and Carling, "Observations on Human Glanders;" Sobol, "A Case of Chronic Nasal Glanders;" Burgess, "Chronic Glanders;" Herold and Erickson, "Human Glanders: Case Report;" Bridget Carr Gregory and David M. Waag, "Glanders," in *Medical Aspects of Biological Warfare*, ed. Zygmunt F. Dembek, *Textbooks of Military Medicine* (Washington, DC: Department of Defense, Office of the Surgeon General, U.S. Army, Borden Institute, 2007): 121–46; and Anno et al., *AMedP-8 (Biological) Methods Report*.

C131 Q Fever Model Parameters

Table C-58. Q Fever Model Parameters Summary Table

Submodel	Type	Parameters
Infectivity	Lognormal distribution	ID_{50} = 30 organisms Probit slope = 0.782 probits/log(dose)
Incubation period	Log-linear function	a = 19.6, b = -1.88
Lethality, if symptomatic	Rate	0%
Duration of illness	Lognormal distribution	Mean = 12.1 days Standard deviation = 6.66 days

1. Infectivity. The infectious dose of *Coxiella burnetii* is modeled as a log-probit function with a probit slope of 0.782 probits/log(dose) and an ID_{50} of 30 organisms (see Section A108.6).

2. Incubation period. The time spent in the incubation period for Q fever is modeled as a function of the inhaled dose. The log-linear function that represents the incubation period is:

$$t = a + b*\log(d)$$

where:

t is the time post exposure [days],

d is the dose of *Coxiella burnetii* [organisms],

a = 19.6, and

b = -1.88.[21]

3. Lethality. Q fever is modeled as non-lethal. Therefore $p_{\text{f-Q-Fev}}(d_n) = 0$ for all values of d_n.

4. Injury profile. Q fever has only one injury profile—for survivors—associated with it. The profile characterizes the symptomatic period of illness as a single stage. The signs and symptoms characterizing Q fever, as well as the corresponding sign/symptom severity level, are described in Table C-59.

[21] Anno et al., *AMedP-8 (Biological) Methods Report*, 130, derived from data in Tigertt and Benenson, "Studies on Q Fever in Man."

Table C-59. Q Fever Injury Profile

	Stage 1
Signs and Symptoms (S/S)	Fever, chills, headache, myalgia. Pneumonia; hepatitis.
S/S Severity	2 (Moderate)
Outlook	Patient is likely to recover.

5. Duration of illness. Duration of illness for Q fever is modeled as a lognormally distributed random variable with a mean value of 12.1 days and a standard deviation of 6.66 days, such that the cumulative fraction of persons who complete Stage 1 (the entire illness) is:

$$F_{\text{Stg1-Q-Fev}}(t) = \frac{1}{2} + \frac{1}{2} erf\left[\frac{\ln(t) - \mu}{\sigma\sqrt{2}}\right]$$

where:

$F_{\text{Stg1-Q-Fev}}$ is the fraction of persons ill with Q fever who have completed Stage 1,

t is the time post exposure [days],

M is the mean incubation period [= 12.1 days],

S is the standard deviation of the incubation periods [= 6.66 days],

μ is the mean of the variable's natural logarithm [$= \ln\left(\frac{M^2}{\sqrt{S^2+M^2}}\right) = \ln\left(\frac{12.1^2}{\sqrt{6.66^2+12.1^2}}\right)$ = 2.36],

σ is the standard deviation of the variable's natural logarithm [$= \sqrt{\ln\left(\left(\frac{S}{M}\right)^2 + 1\right)}$ $= \sqrt{\ln\left(\left(\frac{6.66}{12.1}\right)^2 + 1\right)}$ = 0.514], and

erf is the error function where $erf(x) = \frac{2}{\sqrt{\pi}}\int_0^x e^{-t^2}\, dt$.[22]

6. Prophylaxis. No prophylaxis is modeled for Q fever.

[22] Derived from data in E. H. Derrick, "The Course of Infection with *Coxiella burneti*," *The Medical Journal of Australia* 1, no. 21 (May 26, 1973): 1051–57; and J. W. Hornibrook and K. R. Nelson, "An Institutional Outbreak of Pneumonitis I. Epidemiological and Clinical Studies," *Public Health Reports* 55, no. 43 (October 25, 1940): 1936–44.

C132 SEB Model Parameters

Table C-60. SEB Model Parameters Summary Table

Submodel	Type	Parameters
Infectivity	Lognormal distribution	ED_{50} = 0.026 μg/man; Probit slope = 2.44 probits/log(dose)
Lethality	Lognormal distribution	LD_{50} = 1.40 μg/man; Probit slope = 2.44 probits/log(dose)
Incubation period	Constant	9 hours
Duration of illness		
Stage 1	Log-linear function	a = 6.10, b = 371 Maximum = 192 hours
Stage 2	Constant	One week

1. Effectivity. The effective dose of SEB is modeled as a log-probit function with a probit slope of 2.44 probits/log(dose) and an ED_{50} of 0.026 μg/man (see Section A108.7).

2. Latent period. The time spent in the latent period for SEB intoxication is modeled as a constant value of nine hours for all persons who will become ill.[23]

3. Lethality. The lethal dose of SEB is modeled as a log-probit function with a probit slope of 2.44 probits/log(dose) and an LD_{50} of 1.4 μg/man (see Section A108.7).

4. Injury profile. Distinct injury profiles exist for survivors and non-survivors of SEB intoxication. Each injury profile characterizes the symptomatic period of illness and divides this period into either one (for non-survivors) or two (for survivors) stages. The signs and symptoms characterizing each stage, as well as the corresponding sign/symptom severity level for each stage, are described in Tables C-61 and C-62.[24] The duration of each stage is determined by the "duration of illness" models discussed in the following section.

[23] Derived from data in Sheldon Sidell, "Human Clinical Syndrome Associated with Accidental Exposure to Aerosolized Staphylococcal Enterotoxin B," in *Special Report to Commission on Epidemiological Survey*, ed. H. G. Dangerfield, No. 65-FDS-1662 (Ft. Detrick, Frederick, MD, April 1965): 25–52.

[24] Rusnak et al., "Laboratory Exposures to Staphylococcal Enterotoxin B."

Table C-61. SEB Survivor Injury Profile

	Stage 1	Stage 2
Signs and Symptoms (S/S)	Cough, headache, chest pain, myalgia, elevated temperature, vomiting, nausea, and anorexia.	Non-productive cough.
S/S Severity	3 (Severe)	1 (Mild)
Outlook	Individual will progress to Stage 2.	Individual will likely recover.

Table C-62. SEB Non-Survivor Injury Profile

	Stage 1
Signs and Symptoms (S/S)	Cough, headache, chest pain, myalgia, elevated temperature, vomiting, nausea, and anorexia.
S/S Severity	3 (Severe)
Outlook	Individual will likely die without treatment.

5. Duration of illness.

a. The time spent in Stage 1 is modeled the same for both survivors and non-survivors and is a function of the inhaled dose. The linear function that represents the duration of Stage 1 is:

$$t_{Stg1} = a + b*d$$

where:

t_{Stg1} is the time since completing the latent period and entering Stage 1 [days],

d is the dose of SEB [μg/man], for D <= 0.5 μg/man;

a = 6.10, and

b = 371.[25]

At doses above 0.5 μg, t_{Stg1} = 192 hours (8 days).

b. The time spent in Stage 2 for survivors is modeled as a constant value of one week.[26]

6. Prophylaxis. No prophylaxis is modeled for SEB.

C133 Tularemia Model Parameters

Table C-63. Tularemia Model Parameters Summary Table

Submodel	Type	Parameters
Infectivity	Lognormal distribution	ID_{50} = 10 organisms Probit slope = 1.90 probits/log(dose)
Incubation period	Log-linear function	a = 6.54, b = -0.821 (for dose < 106,064 organisms)
	Log-quadratic function	e = 11.0, f = -2.59, g = 0.176 (106,064 organisms ≤ dose < 9,019,577 organisms)
	Constant	1.5 days (dose ≥ 9,019,577 organisms)
Lethality, if symptomatic	Rate	75%
Duration of illness (non-survivor)		
Stage 1	Constant	9 days
Stage 2	Constant	6 days
Duration of illness (survivor)		
Stage 1	Constant	12 days
Stage 2	Constant	28 days
Stage 3	Constant	12 weeks

[25] Anno et al., *AMedP-8 (Biological) Methods Report*, 94.

[26] Derived from data in Sidell, "Human Clinical Syndrome."

1. Infectivity. The infectious dose of *Francisella tularensis* is modeled as a log-probit function with a probit slope of 1.90 probits/log(dose) and an ID_{50} of 10 organisms (see Section A108.8).

2. Incubation period. The time spent in the incubation period for tularemia is modeled as a piece-wise function of the dose.

a. The log-linear function that represents the incubation period for doses less than 106,064 organisms is:

$$t = a + b*\log(d)$$

where:

t is the time post exposure [days],

d is the dose of *Francisella tularensis* [organisms],

a = 6.54, and

b = -0.821.[27]

b. The quadratic function that represents the incubation period for doses greater than or equal to 106,064 organisms but less than 9,019,577 organisms is:

$$t = e + f*\log(d) + g*\log(d)^2$$

where:

t is the time post exposure [days],

d is the dose of *Francisella tularensis* [organisms],

e = 11.0,

f = -2.59, and

g = 0.176.[28]

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[27] George H. Anno and Arthur P. Deverill, *Consequence Analytic Tools for NBC Operations Volume 1: Biological Agent Effects and Degraded Personnel Performance for Tularemia, Staphylococcal Enterotoxin B (SEB) and Q-Fever*, Defense Special Weapons Agency Report DSWA-TR-97-61-V1, October 1998.

[28] Ibid.

c. For doses greater than or equal to 9,019,577 organisms, the incubation period is modeled as a constant 1.5 days.[29]

3. Lethality. Tularemia is modeled with a case fatality rate of 75%. Therefore $p_{f\text{-}Tul}(d_n) = 0.75 * p_{E\text{-}Tul}(d_n)$.

4. Injury profile. Distinct injury profiles exist for survivors and non-survivors of tularemia. Each injury profile characterizes the symptomatic period of illness and divides this period into two (for non-survivors) or three (for survivors) distinct stages. The signs and symptoms characterizing each stage as well as the corresponding sign/symptom severity level for each stage are described in Tables C-64 and C-65.[30] The duration of each stage is determined by the "duration of illness" models discussed in the following section.

Table C-64. Tularemia Survivor Injury Profile

	Stage 1	Stage 2	Stage 3
Signs and Symptoms (S/S)	High fever, headache, chills, sore throat, myalgia, chest pain.	Stage 1 S/S plus mild pneumonia.	Malaise, severe weakness.
S/S Severity	3 (Severe)	3 (Severe)	2 (Moderate)
Outlook	Individual will progress to Stage 2.	Individual will progress to Stage 3.	Individual will likely recover.

Table C-65. Tularemia Non-Survivor Injury Profile

	Stage 1	Stage 2
Signs and Symptoms (S/S)	High fever, headache, chills, sore throat, myalgia, chest pain.	Stage 1 S/S plus severe pneumonia, respiratory distress.
S/S Severity	3 (Severe)	4 (Very Severe)
Outlook	Individual will progress to Stage 2.	Individual will likely die without treatment.

29 Ibid.

30 Derived from descriptions found in Samuel Saslaw et al., "Tularemia Vaccine Study II. Respiratory Challenge," *Archives of Internal Medicine* 107 (1961): 702–14; Fred R. McCrumb Jr., "Aerosol Infection of Man with *Pasteurella tularensis*," *Bacteriological Review* 25 (1961): 262–67; and Byron M. Stuart and Roscoe L. Pullen, "Tularemic Pneumonia: Review of American Literature and Report of 15 Additional Cases," *American Journal of Medical Science* 210 (1945): 223–36.

5. Duration of illness.

a. For survivors, the duration of illness for each stage of illness is modeled as a constant, such that

$$F_{\text{Stg1-Tul}_S}(t_{\text{Stg1}}) = 1, \text{ for } t_{\text{Stg1}} \geq 12 \text{ days}$$

$$\text{else} = 0$$

where:

$F_{\text{Stg1-Tul}_S}$ is the cumulative fraction of survivors with tularemia who have completed Stage 1 and entered Stage 2 of the disease,

t_{Stg1} is the time since completing the incubation period [days],

$$F_{\text{Stg2-Tul}_S}(t_{\text{Stg2}}) = 1, \text{ for } t_{\text{Stg2}} \geq 28 \text{ days}$$

$$\text{else} = 0$$

where:

$F_{\text{Stg2-Tul}_S}$ is the cumulative fraction of survivors with tularemia who have completed Stage 2 and entered Stage 3 of the disease,

t_{Stg2} is the time since completing Stage 1 [days], and

$$F_{\text{Stg3-Tul}_S}(t_{\text{Stg3}}) = 1, \text{ for } t_{\text{Stg3}} \geq 84 \text{ days}$$

$$\text{else} = 0$$

where:

$F_{\text{Stg3-Tul}_S}$ is the cumulative fraction of survivors with tularemia who have completed Stage 3 and recovered from the disease, and

t_{Stg3} is the time since completing Stage 2 [days].[31]

b. For non-survivors, the duration of illness for each stage of illness is similarly modeled as a constant, such that

$$F_{\text{Stg1-Tul}_{N\text{-}S}}(t_{\text{Stg1}}) = 1, \text{ for } t_{\text{Stg1}} \geq 9 \text{ days}$$

$$\text{else} = 0$$

[31] Derived from data in Stuart and Pullen, “Tularemic Pneumonia,” 233.

where:

$F_{\text{Stg1-Tul}_{\text{N-S}}}$ is the cumulative fraction of non-survivors with tularemia who have completed Stage 1 and entered Stage 2 of the disease,

t_{Stg1} is the time since completing the incubation period [days], and

$$F_{\text{Stg2-Tul}_{\text{N-S}}}\left(t_{\text{Stg2}}\right) = 1, \text{ for } t_{\text{Stg2}} \geq 6 \text{ days}$$

$$\text{else} = 0$$

where:

$F_{\text{Stg2-Tul}_{\text{N-S}}}$ is the cumulative fraction of non-survivors with tularemia who have completed Stage 2 and died from the disease,

t_{Stg2} is the time since completing Stage 1 [days].[32]

[32] Ibid.

7. *AMedP-8(C)* Annex E Addenda

This chapter presents the addenda to *AMedP-8(C)* Annex E, specifically the references to be added for the new agents. To remain consistent with the current organization of this annex, the agent-specific reference sections should be arranged alphabetically in Annex E following the NATO References and the General References. The new order should be as follows:

E101 NATO References

E102 General References

E103 Anthrax References

E104 Blast References

E105 Botulism References

E106 Brucellosis References

E107 GB/VX References

E108 Glanders References

E109 HD References

E110 Plague References

E111 Q Fever References

E112 Radiation References

E113 Radiological References

E114 SEB References

E115 Smallpox References

E116 Thermal References

E117 Tularemia References

E118 VEE References

Below are the agent-specific reference sections to be added to Annex E, as well as one specific reference to be added to Section E102 “General References.”

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Appendix B
References

In addition to the agent-specific references to be added to *AMedP-8(C)* (previously identified in Chapter 7), the following documents were referenced in the production of this document.

Anno, George H., Michael Lockhart, Larry Karns, Gene E. McClellan, Gillian L. Rickmeier, Ronald M. Bloom, and Leigh N. Matheson. *Biological Agent Exposure and Casualty Estimation: AMedP-8 (Biological) Methods Report.* GS-35F-4923H. Fairfax, VA: General Dynamics Advanced Information Systems, 2005.

Curling, Carl A., Julia K. Burr, Lusine Danakian, Deena S. Disraelly, Lucas A. LaViolet, Terri J. Walsh, and Robert A. Zirkle. *Technical Reference Manual: Allied Medical Publication 8(C), NATO Planning Guide for the Estimation of Chemical, Biological, Radiological, and Nuclear (CBRN) Casualties.* IDA Document D-4082. Alexandria, VA: Institute for Defense Analyses, June 2010.

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Appendix C
Abbreviations

AMedP-8	Allied Medical Publication 8
CBRE	Chemical, Biological, Radiological, Explosive
CBRN	Chemical, Biological, Radiological, Nuclear
CDF	Cumulative Distribution Function
CFU	Colony Forming Unit
DOW	Died of Wounds
ED	Effective Dose
ID	Infectious Dose
IDA	Institute for Defense Analyses
NATO	North Atlantic Treaty Organization
SEB	Staphylococcal Enterotoxin B
VEE	Venezuelan Equine Encephalitis
WIA	Wounded in Action

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14. ABSTRACT

The North Atlantic Treaty Organization (NATO) Allied Medical Publication 8(C), *NATO Planning Guide for the Estimation of CBRN Casualties* (*AMedP-8(C)*) currently describes a methodology for estimating the numbers of persons developing illness or dying from anthrax, botulism, Venezuelan equine encephalitis, plague, and smallpox. Five additional biological warfare agents have recently been modeled according to the same methodology; these consist of the causative agents of brucellosis, glanders, Q fever, and tularemia, as well as the biotoxin staphylococcal enterotoxin B. Incorporating these five agents into the published NATO guide will require substantial changes to several chapters of the document as well as three of its annexes.

This document presents the text, tables, and figures that will need to be added to *AMedP-8(C)* if these agents are integrated into the document. Each chapter of this document contains the addenda to one chapter or annex in *AMedP-8(C)*, and sections are written to be consistent with the existing contents of the NATO document. In addition to the addenda themselves, this document provides instructions on where to add each new section to facilitate the process of updating *AMedP-8(C)* with the five recently modeled agents.

15. SUBJECT TERMS

Casualty estimation, biological warfare agents, CBRN, modeling, AMedP-8, brucellosis, glanders, Q fever, staphylococcal enterotoxin B, SEB, tularemia

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